

Leveraging One Health for the control & elimination of schistosomiasis

Dr Martin Walker & Prof. Joanne Webster

Global Schistosomiasis Alliance, Oct 2023, Chicago, IL



What does ChatGPT think?

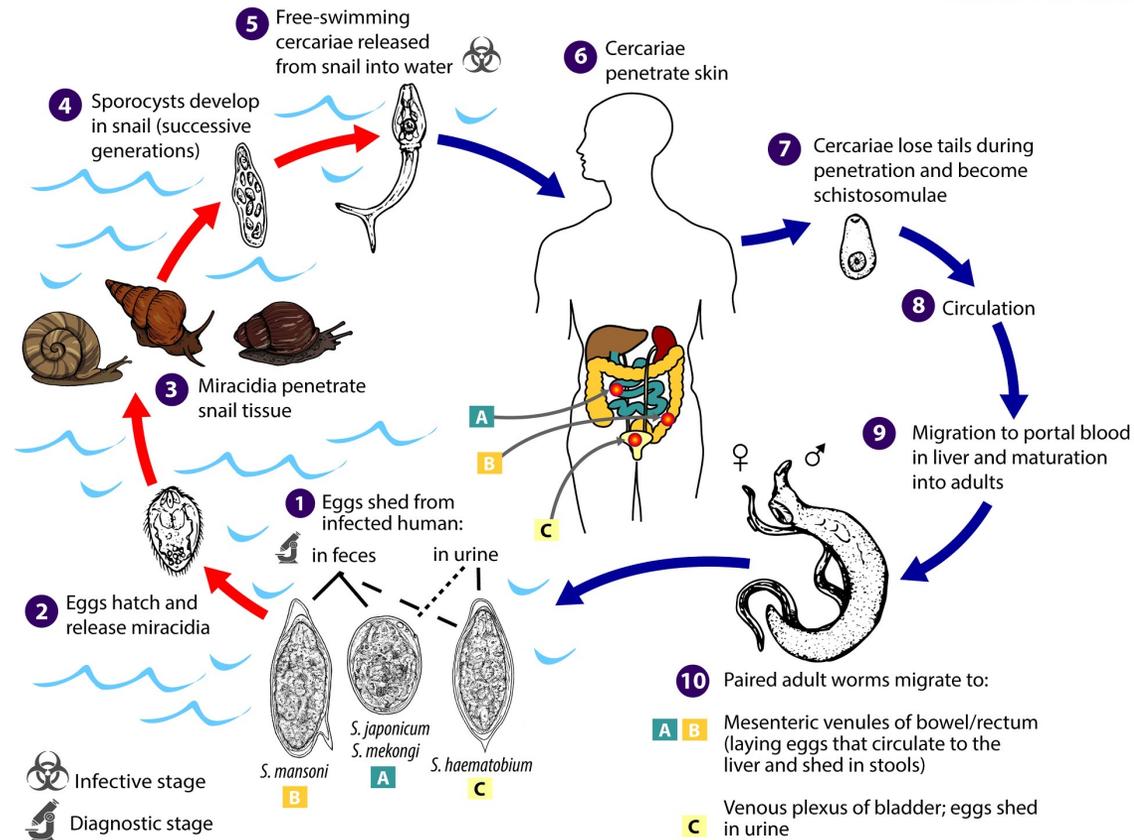
“Leveraging the One Health approach for the control and elimination of schistosomiasis is crucial because this parasitic disease is influenced by a complex interplay of human, animal, and environmental factors”

1. Interdisciplinary collaboration
2. Surveillance and monitoring
 - integrated surveillance systems that track schistosomiasis in both humans and potential animal reservoirs
3. Snail control
4. Health education & community engagement
5. Mass drug administration
 - ensure that MDA programs are well-targeted and integrated with other health services, including veterinary care for animals
6. Animal health management
 - Implement animal health interventions as needed, particularly in areas where zoonotic schistosomiasis is a concern
7. Research & data sharing
 - better understand the epidemiology, transmission dynamics, and ecological aspects of schistosomiasis
8. Environmental management
9. Policy & advocacy
10. Evaluation & feedback

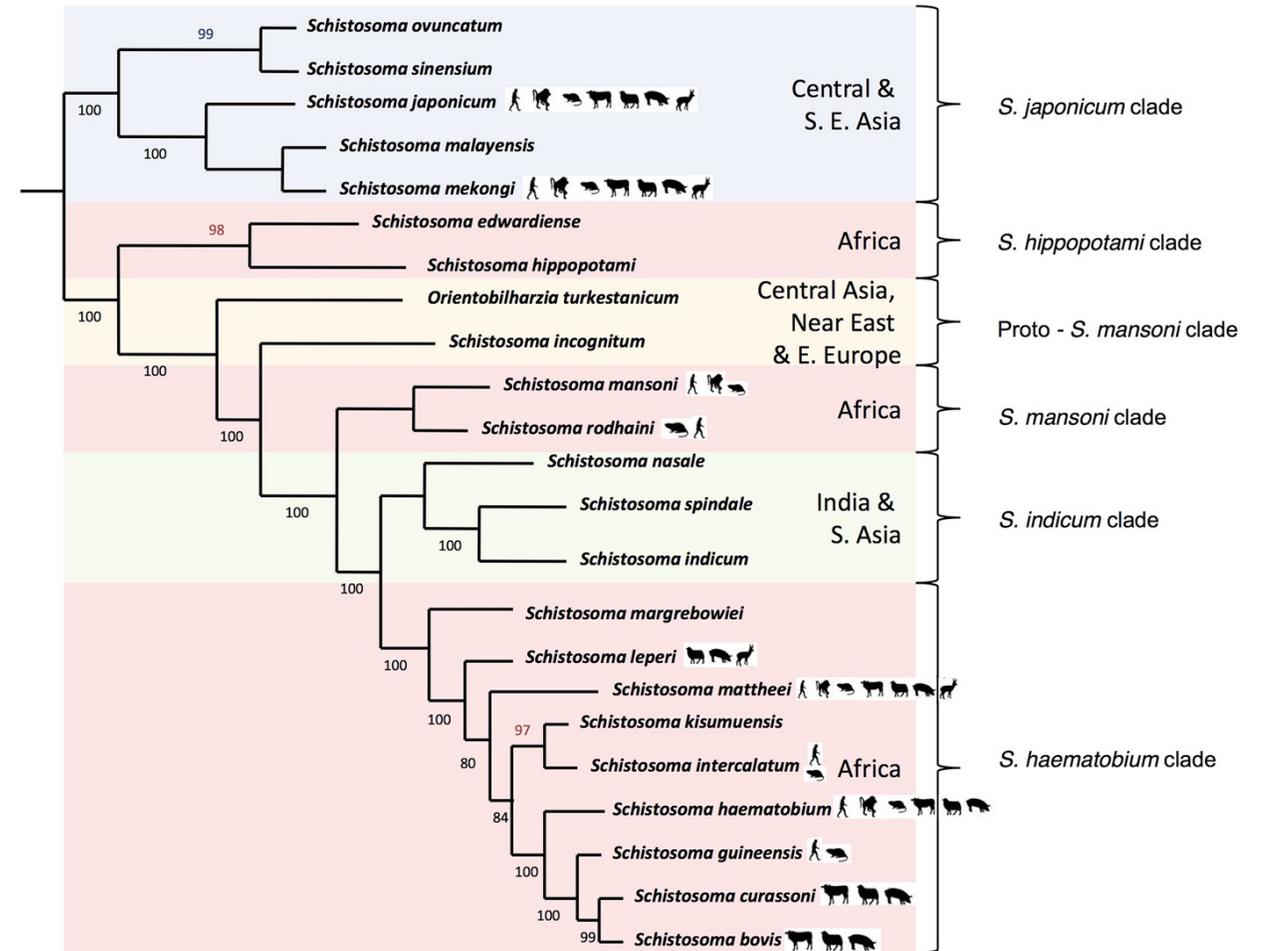
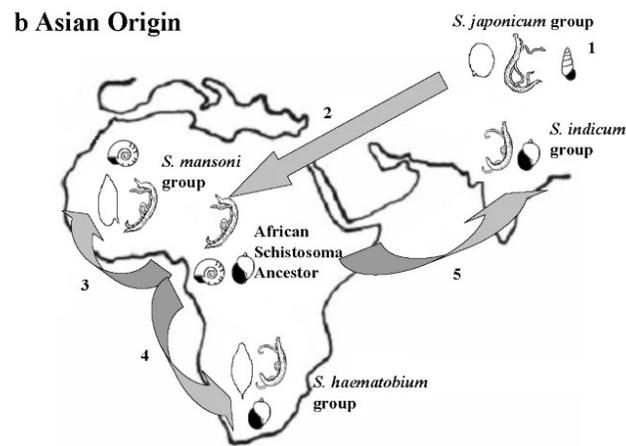
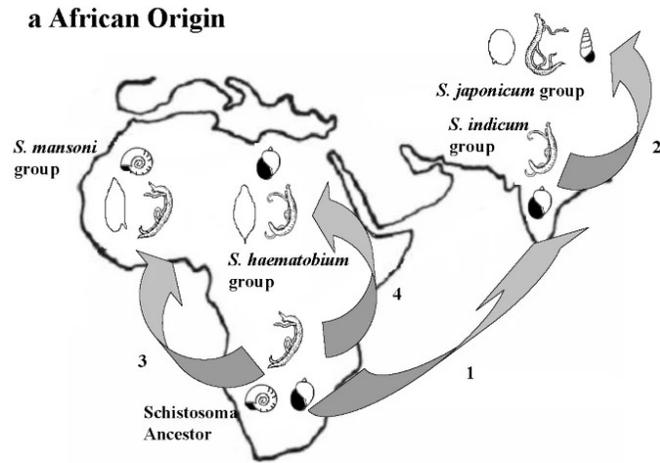
Traditional life cycle of human-infective schistosomes

DPDx

Schistosoma spp.



Schistosomes as multi-host parasites evolved from an avian ancestor

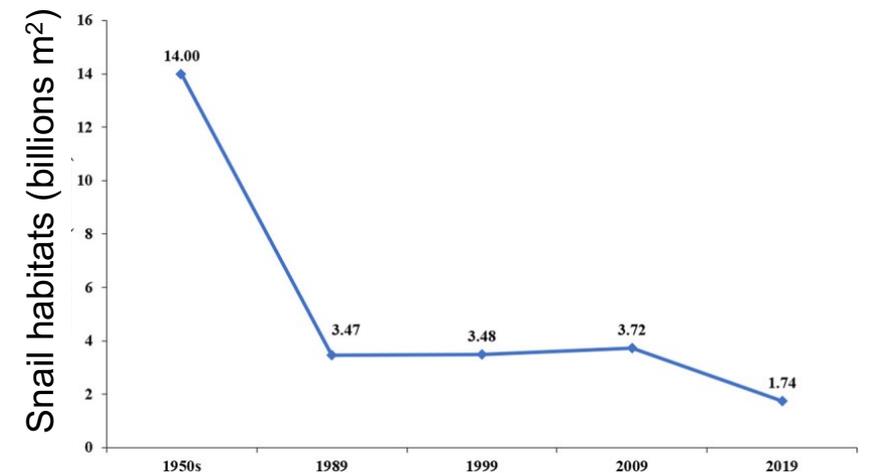
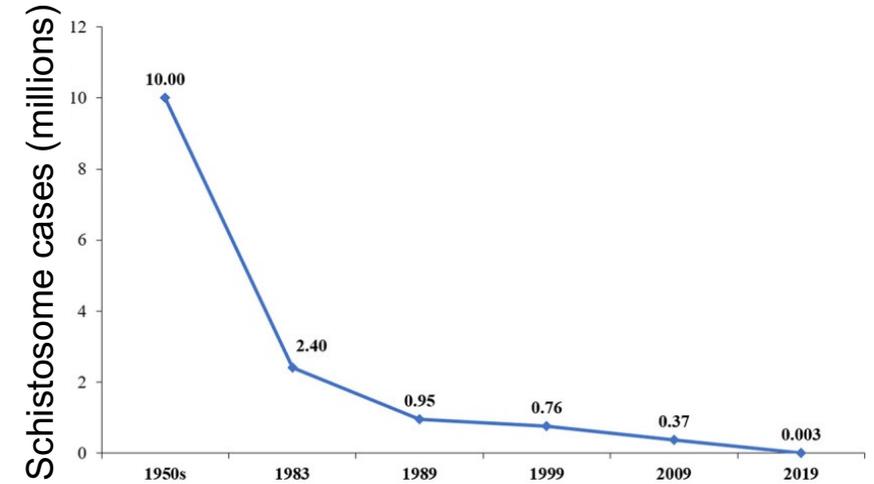


Animal reservoirs & zoonotic transmission – *S. japonicum* in China

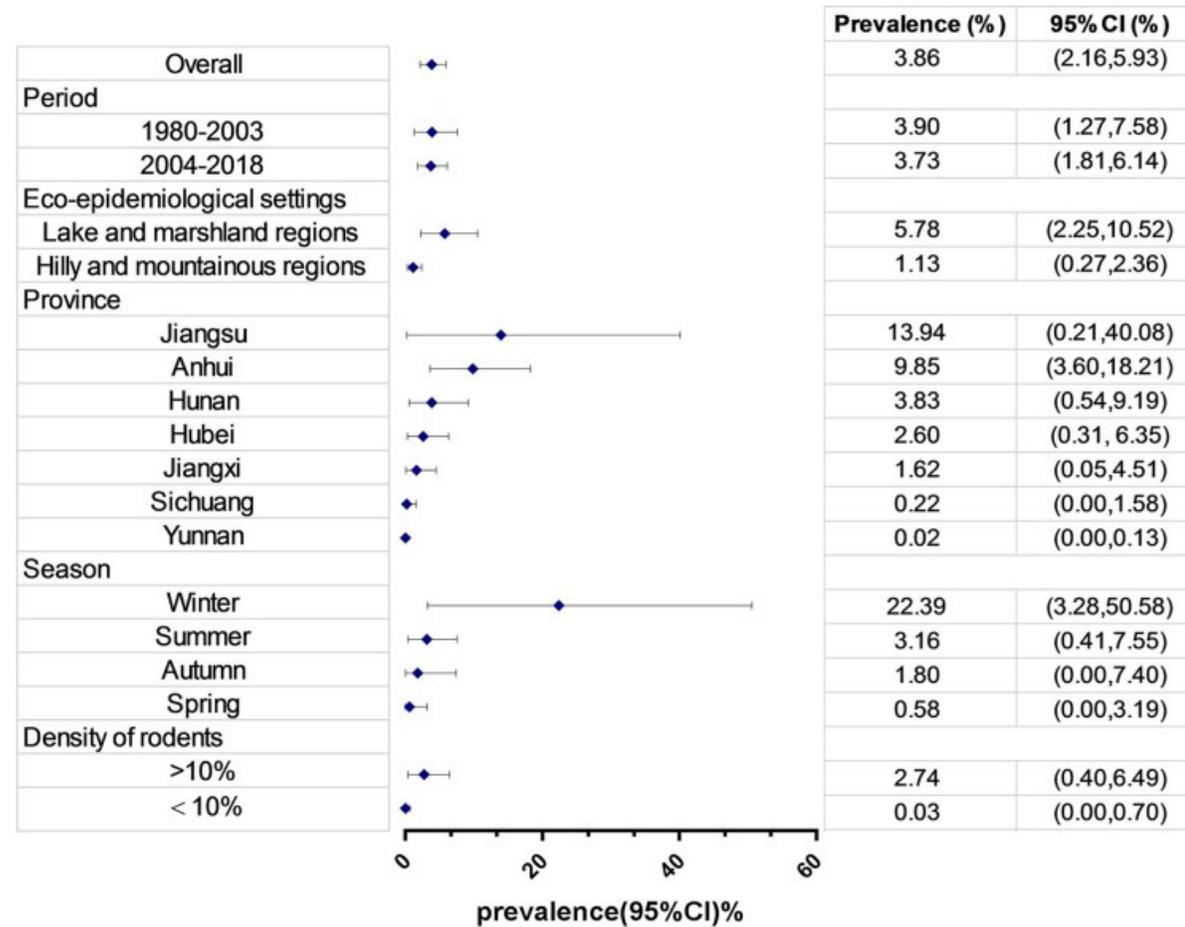
	Marshland region			Hilly region		
	Guanghui	Heping	Xingzhuang	Longquan	Longshang	Yuantou
Humans	<0.01	0	<0.01	0	0.3	0.2
Buffaloes	0.1	0.3	0.1	-	-	-
Cattle	1.8	1.1	2.9	0	0.1	0
Goats	-	-	0.1	-	-	-
Dogs	0.0	0.0	0.0	0.2	0.0	0.1
Cats	0.0	0.0	0.0	0.0	0.0	0.0
Rodents	0.0	0.2	0.0	1.8	1.3	1.5
R ₀ (overall)	1.9	1.3	2.9	2.0	1.4	1.6

Integrated control – *S. japonicum* in China

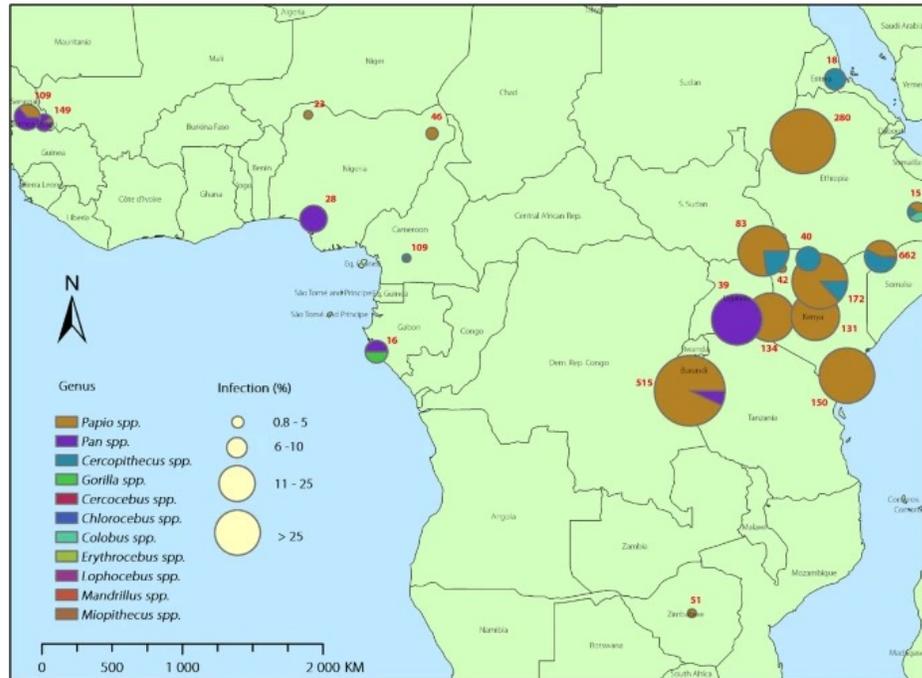
- >70 years of integrated control (praziquantel, health education, mollusciciding, environmental modification, behavioural change etc.)
- 99% reduction in human cases since 1950s
- Transmission controlled in 95% of 450 counties considered endemic; 67 have achieved elimination
- ...but reservoirs in goats, dogs & **rodents** remain a challenge...



Schistosomiasis in rodents maintained or increased over time



S. mansoni in non-human primates – incidental hosts or animal reservoir?



Richards et al. *Infect Dis Poverty* 2019

RESEARCH ARTICLE

Genetic evidence for the role of non-human primates as reservoir hosts for human schistosomiasis

Tadesse Kebede^{1,2,3*}, Nicolas Bech⁴, Jean-François Allienne³, Rey Olivier³, Berhanu Erko^{2†}, Jerome Boissier^{3‡}

Kebede et al. *PLoS NTDs* 2020

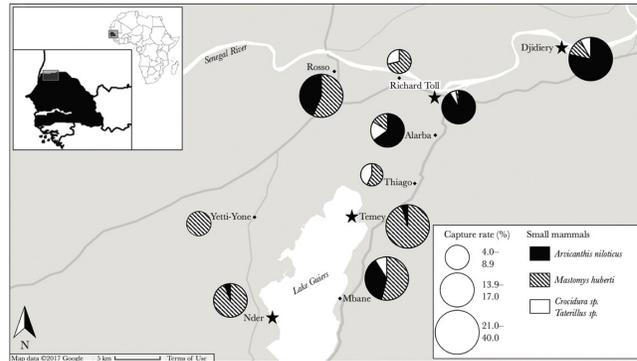
Am. J. Trop. Med. Hyg., 103(6), 2020, pp. 2278–2281
doi:10.4269/ajtmh.20-0282
Copyright © 2020 by The American Society of Tropical Medicine and Hygiene

Identification of *Schistosoma mansoni* Infection in a Nonhuman Primate from St. Kitts More than 50 Years after Interruption of Human Transmission

Jennifer K. Ketzis,^{1††} Manigandan Lejeune,^{2†} Ian Branford,¹ Amy Beierschmitt,³ and Arve Lee Willingham¹

Ketzis et al. *Am J Trop Med Hyg* 2020

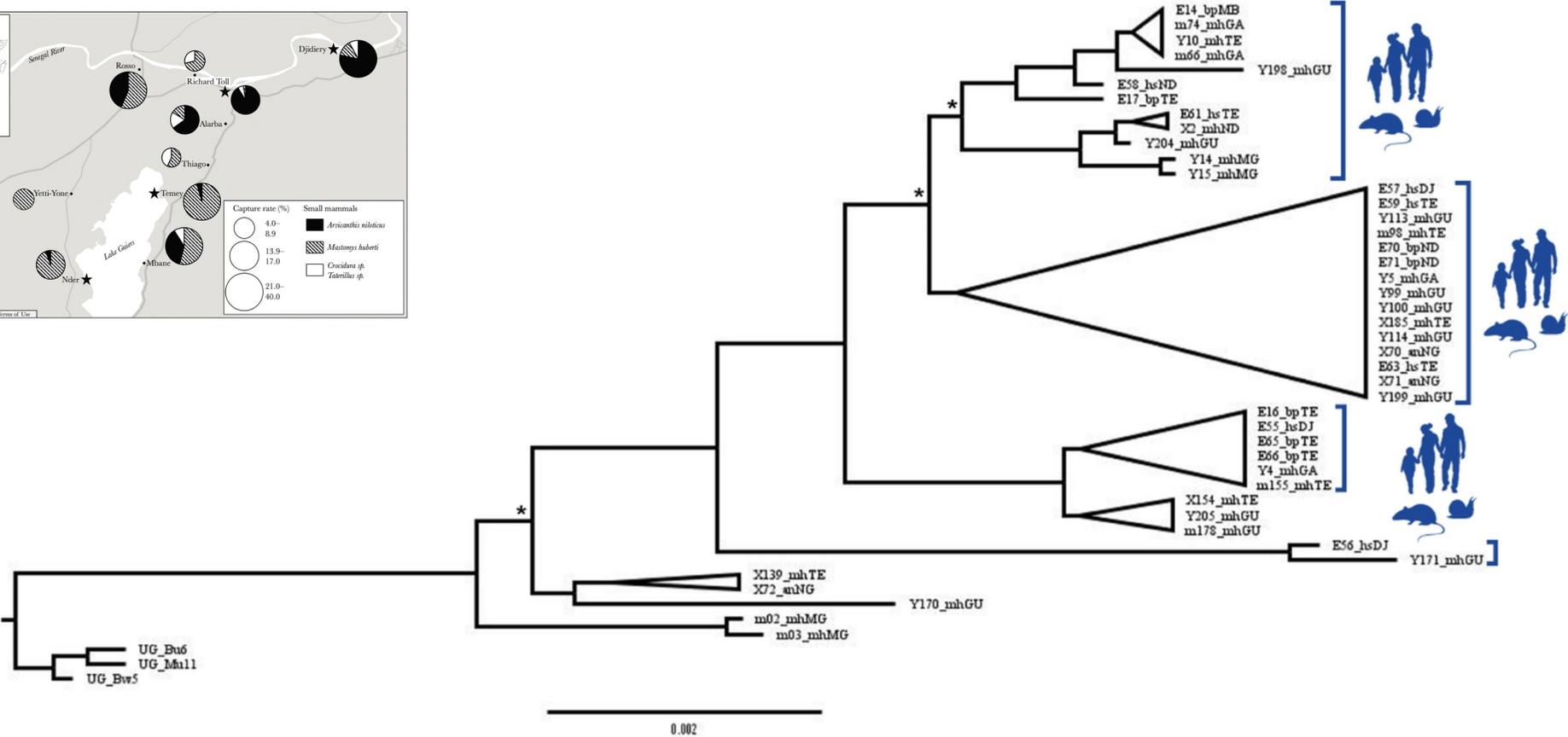
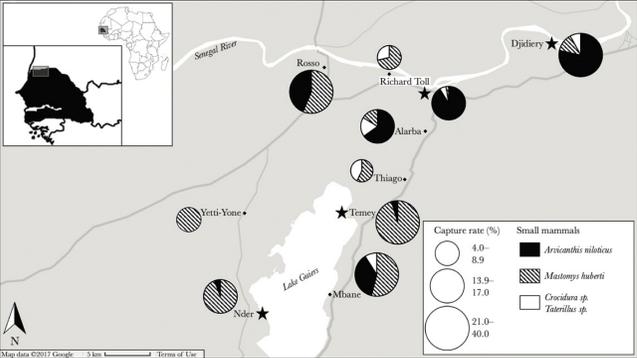
S. mansoni in rodents – local reservoirs in Senegal



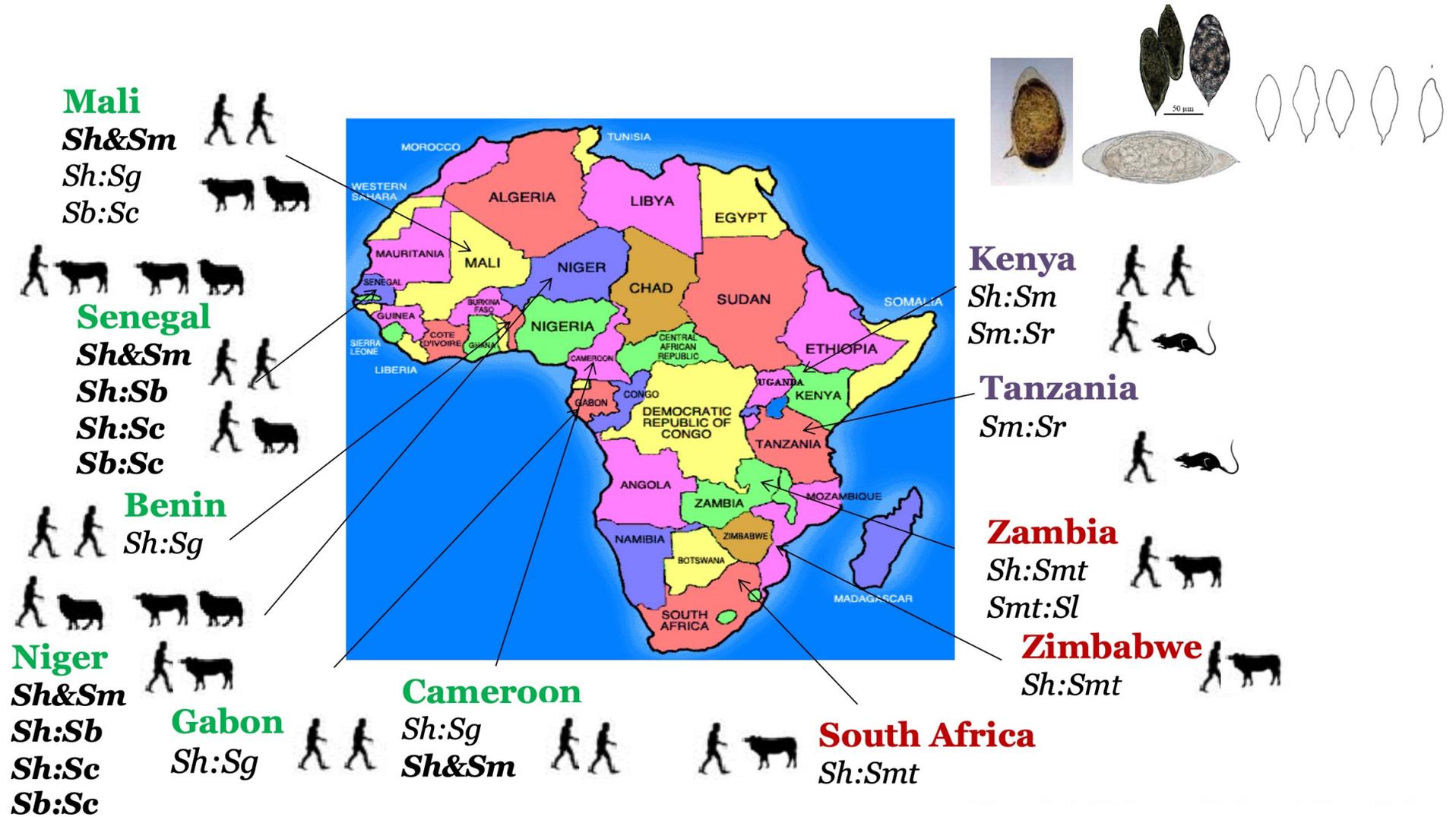
S. mansoni, *S. bovis* & *S. haematobium* x *S. bovis* hybrids identified with prevalence from 1.9% to 28.6%

Location (Capture Rate)	<i>Arvicanthis niloticus</i>			<i>Mastomys huberti</i>		
	Juveniles (n = 70)	Adults (n = 145)	Total (n = 215)	Juveniles (n = 53)	Adults (n = 119)	Total (n = 172)
Richard Toll (RT)*						
Djidiery (31.6%)	17	29 <i>Sb</i> 13.8%	46 <i>Sb</i> 8.7%	0	2	2
Alarba (17.1%)	7	21	28	1	6	7
RT canal (14.4%)	25	48 <i>Sm</i> 2.1%	73 <i>Sm</i> 1.4%	0	2	2
Thiago (8.7%)	0	0	0	3	1	4
Richard Toll (RT)†						
Rosso (40.0%)	4	2	6	6	4	10
Djidiery (13.5%)	9	14	23	5	5	10
RT river (4.0%)	0	0	0	4	4	8
Lake Guiers†						
Mbane (23.7%)	0	3	3	3	39 <i>Sm</i> 40.0%	42 <i>Sm</i> 28.6%
Temey (22.9%)	0	1	1	6	15 <i>Sh/Sb</i> 6.7%	21 <i>Sh/Sb</i> 4.8%
Nder (13.9%)	1	4	5	21	31 <i>Sm</i> 3.2%	52 <i>Sm</i> 1.9%
Yetti-Yone (8.9%)	0	0	0	3	5	8
Lake Guiers*						
Mbane (30.6%)	7	23	30	1	5	6

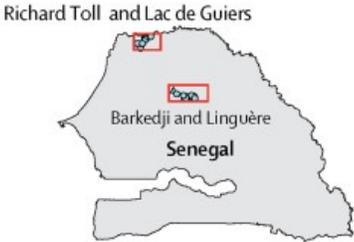
S. mansoni in rodents – local reservoirs in Senegal



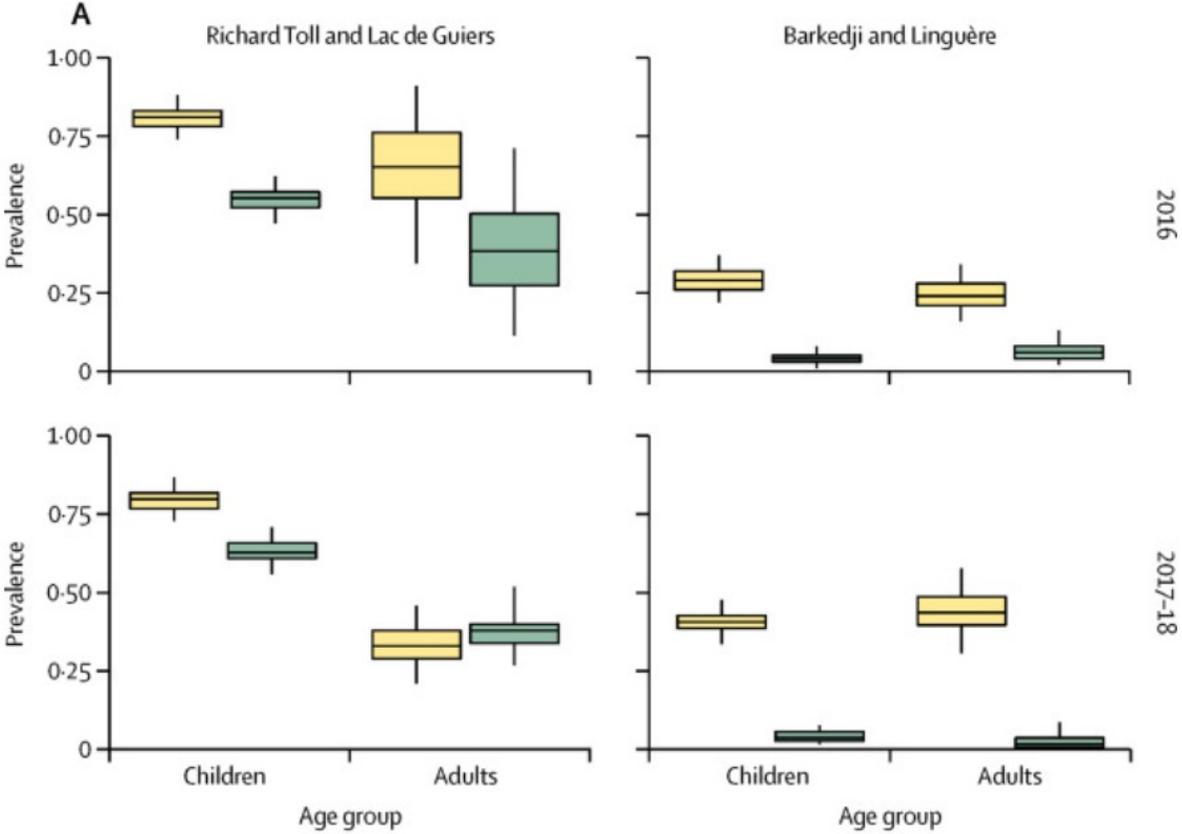
S. haematobium – hybrids with livestock species suspected since 1940s



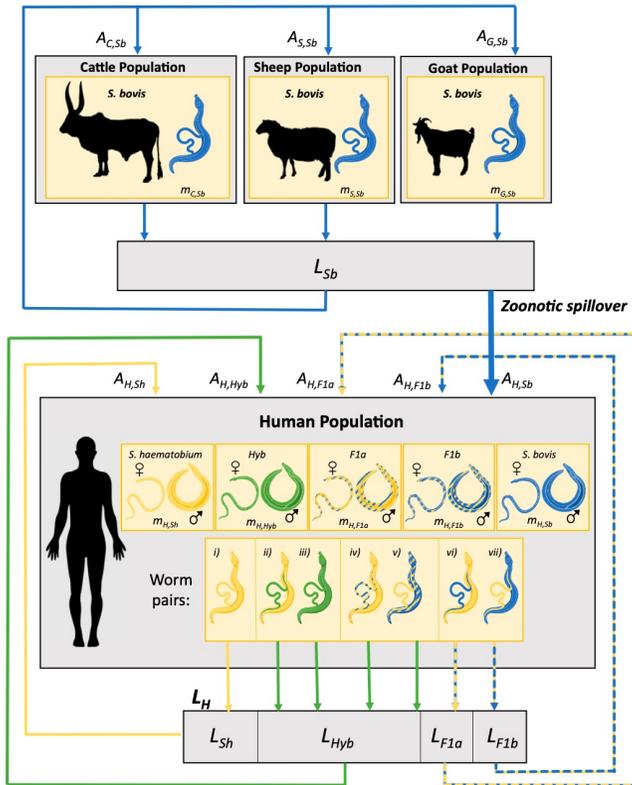
Prevalence of *S. haematobium* hybrids varies by region



Schistosoma genotypes
■ *S. haematobium* ■ *S. haematobium*-*S. bovis* hybrids (hybrid 1 and hybrid 2)



Stable transmission of hybrids in northern Senegal



Genotype	Host	R_0
<i>S. haematobium</i> x <i>S. bovis</i>	Human	1.76 (1.59, 1.99)
<i>S. haematobium</i>	Human	1.9 (1.74, 2.14)
<i>S. bovis</i>	Cattle	1.43 (1.24, 1.85)
<i>S. bovis</i>	Goats	0.03 (0.02, 0.05)
<i>S. bovis</i>	Sheep	0.04 (0.02, 0.08)

One Health & the WHO 2021-2030 NTD Roadmap – what’s new & what’s next?

Category and current assessment	Current status	Actions required
Technical progress  Scientific understanding	<ul style="list-style-type: none"> • Decent understanding of transmission and parasite life cycle • Unclear understanding of resurgence pathways • Gaps in understanding of specific snails, hybrid species and zoonotic reservoirs; zoonotic reservoirs maintain transmission • Insufficient understanding of spectrum of morbidities 	<ul style="list-style-type: none"> • Determine causes and strategies to prevent resurgence and to sustain elimination as a public health problem once achieved • Understand zoonotic transmission and interventions to address zoonotic reservoirs • Determine causes and develop strategies to address areas not responding to treatment • Determine impact of female genital schistosomiasis and association with HIV • Define both economic and health impact of clinical and “subtle” morbidity

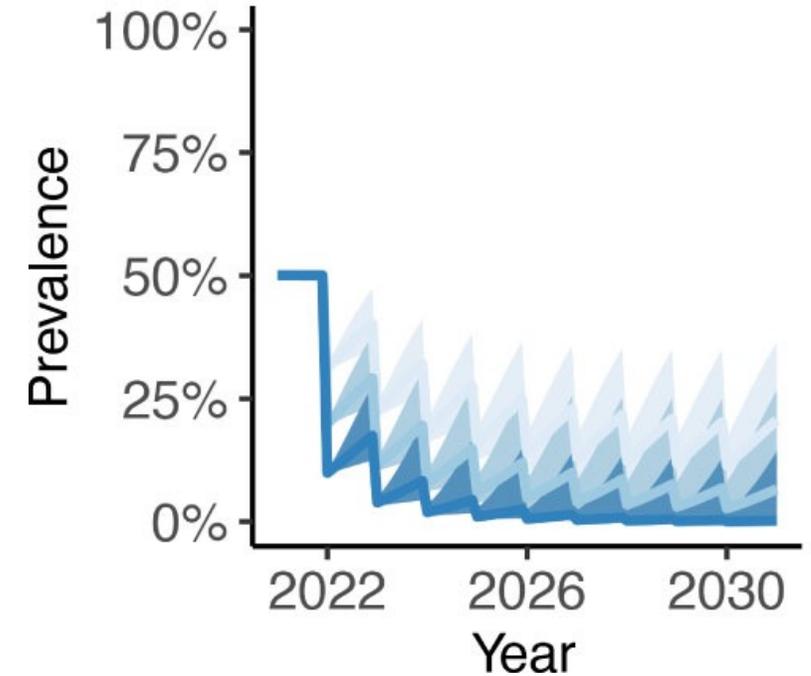
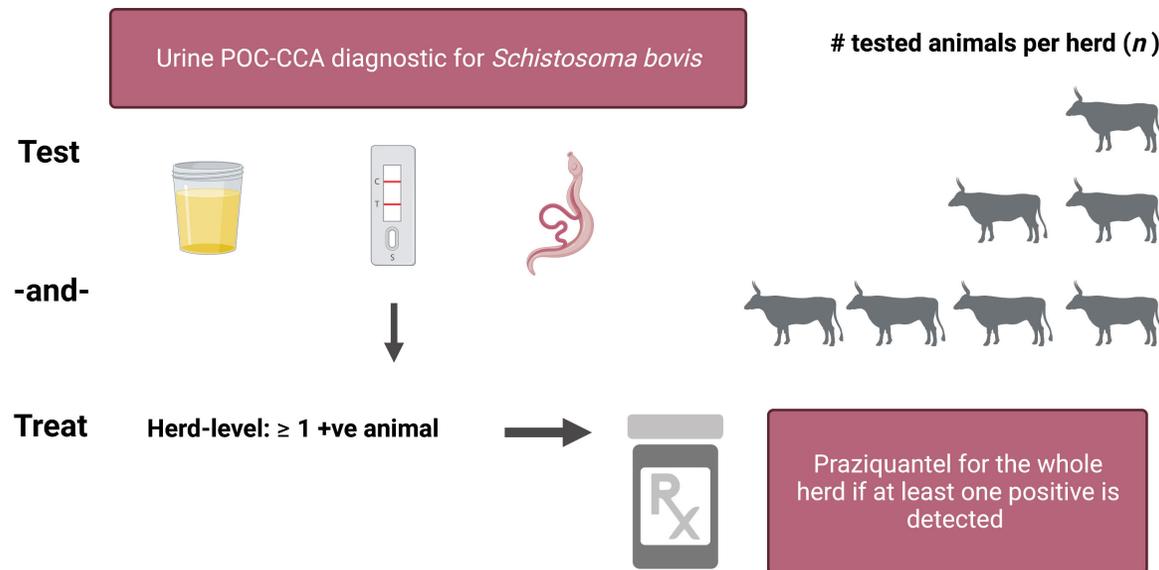





No hindrance towards target Critical action required to reach target

Possible interventions to address zoonotic reservoirs - livestock test & treat with POC-CCA

Simulated Test-and-Treat strategy in an infected herd of cattle



Summary

- Progress towards the control & elimination of schistosomiasis will be enhanced by taking a One Health perspective
- Failure to tackle substantive animal (livestock & wildlife) schistosome reservoirs will blunt human-centric interventions
- Significance of animal reservoirs will likely vary geographically requiring tailoring of local intervention strategies
- Snail control, treatment of livestock, WASH, health education etc. will all be important components of integrated 'One Health' interventions



PHILOSOPHICAL
TRANSACTIONS B

royalsocietypublishing.org/journal/rstb

Opinion piece



Cite this article: Díaz AV, Walker M, Webster JP. 2023 Reaching the World Health Organization elimination targets for schistosomiasis: the importance of a One Health perspective. *Phil. Trans. R. Soc. B* **378**: 20220274.
<https://doi.org/10.1098/rstb.2022.0274>

Reaching the World Health Organization elimination targets for schistosomiasis: the importance of a One Health perspective

Adriana V. Díaz¹, Martin Walker^{1,2} and Joanne P. Webster^{1,2}

¹Department of Pathobiology and Population Sciences, Royal Veterinary College, Hatfield AL9 7TA, UK
²Department of Infectious Disease Epidemiology, London Centre for Neglected Tropical Disease Research, Faculty of Medicine, Imperial College, London W2 1PG, UK

AVD, 0000-0002-8272-0428; MW, 0000-0001-8714-5365; JPW, 0000-0001-8616-4919